



# La RMN, c' est facile !!!

- Phénomène physique: notions indispensables
- Aspects expérimentaux: optimisation
- Traitement numérique: optimisation

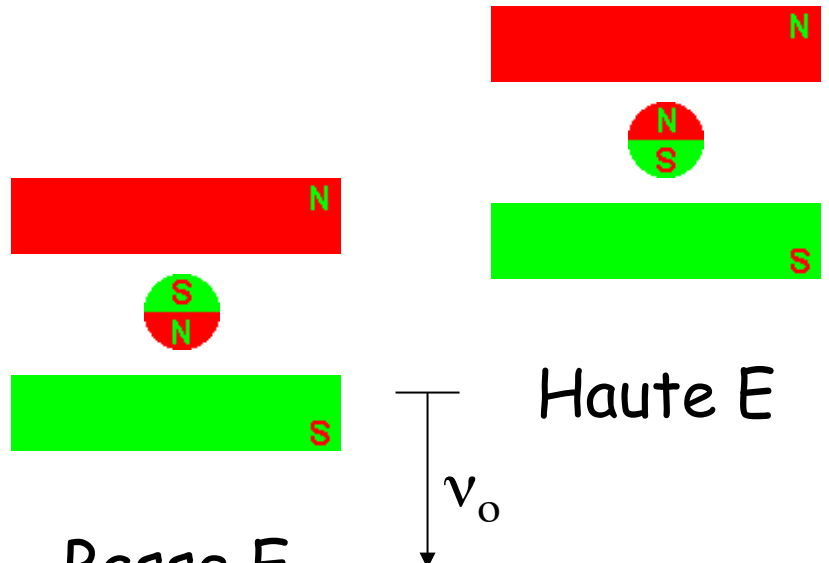
# Phénomène physique: notions indispensables

## Spin:

Propriété intrinsèque d'un élément:  $^1\text{H}$ ,  $^{13}\text{C}$  =  $\pm 1/2$

Comme un aimant dans notre référentiel: 

## Spin dans un champ magnétique $B_0$ :



$\nu_0 = \gamma B_0$

Fréquence de Larmor

$^1\text{H}$ : 300 MHz = 42.6 MHz.T<sup>-1</sup> × 7 T

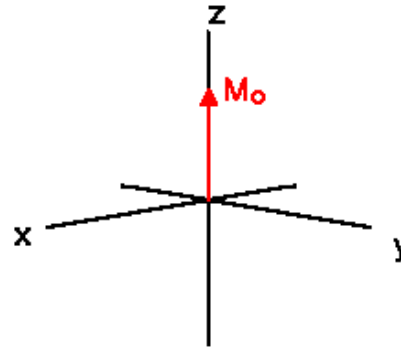
$^{13}\text{C}$ : 75 MHz = 10.7 MHz.T<sup>-1</sup> × 7 T

$E = h \nu_0 = h \gamma B_0$

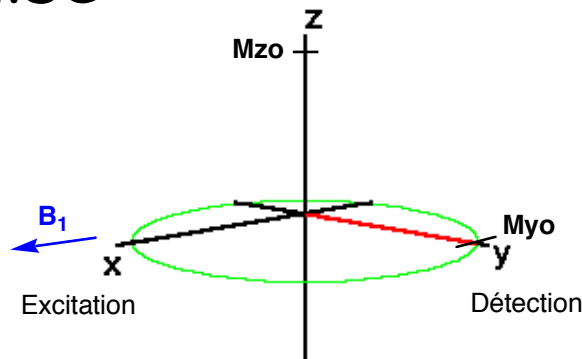
# Phénomène physique: notions indispensables

Paquet de spins dans un champ magnétique  $B_0$ :

Boltzmann:  $\frac{N_{HE}}{N_{BE}} = e^{-E/kT}$   $\longrightarrow$  Magnétisation et Précession à  $\nu_0$



90° pulse

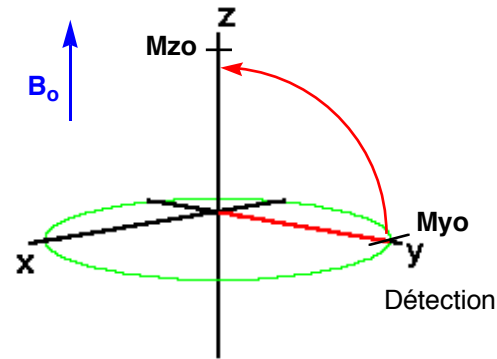


Référentiel tournant à  $\nu_0$

# Phénomène physique: notions indispensables

Relaxation:

Retour à l'équilibre

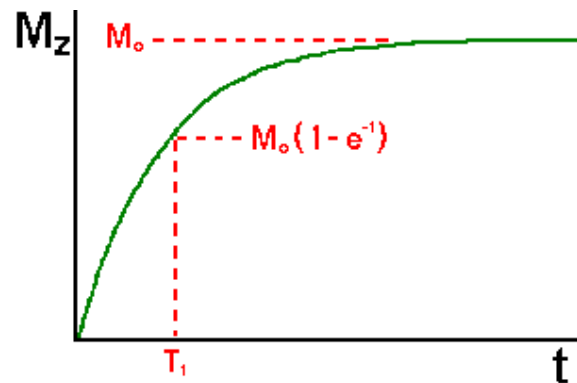


$$T_2 \leq T_1$$

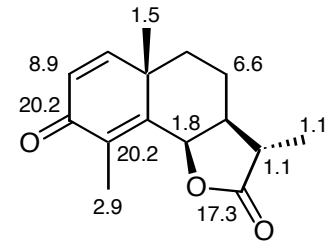
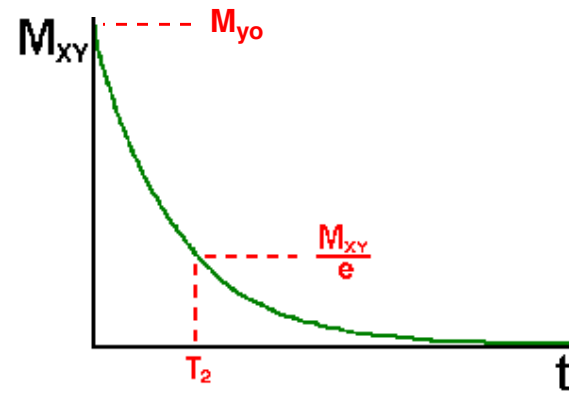
$$^1\text{H}: T_1 \approx 1-3 \text{ s}$$

$$^{13}\text{C}: T_1 \approx 1-20 \text{ s}$$

$$M_z = M_{z_0} (1 - e^{-t/T_1})$$

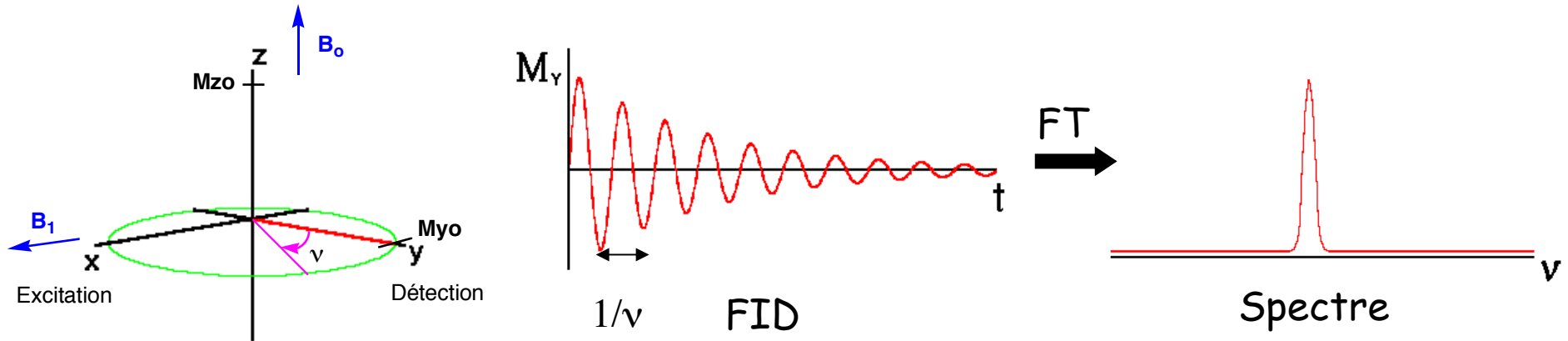


$$M_y = M_{y_0} e^{-t/T_2}$$

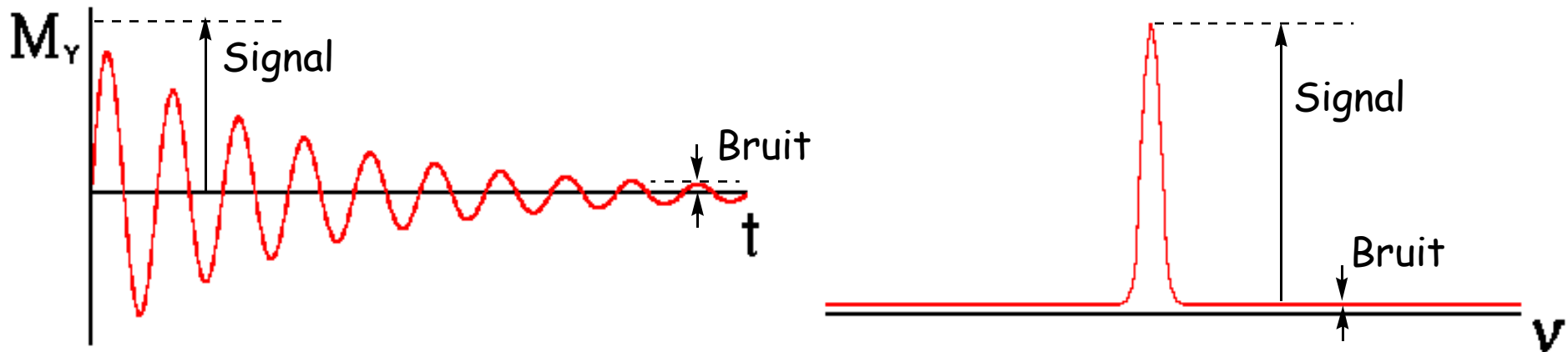


# Phénomène physique: notions indispensables

## 2 Paquets de spins différents:

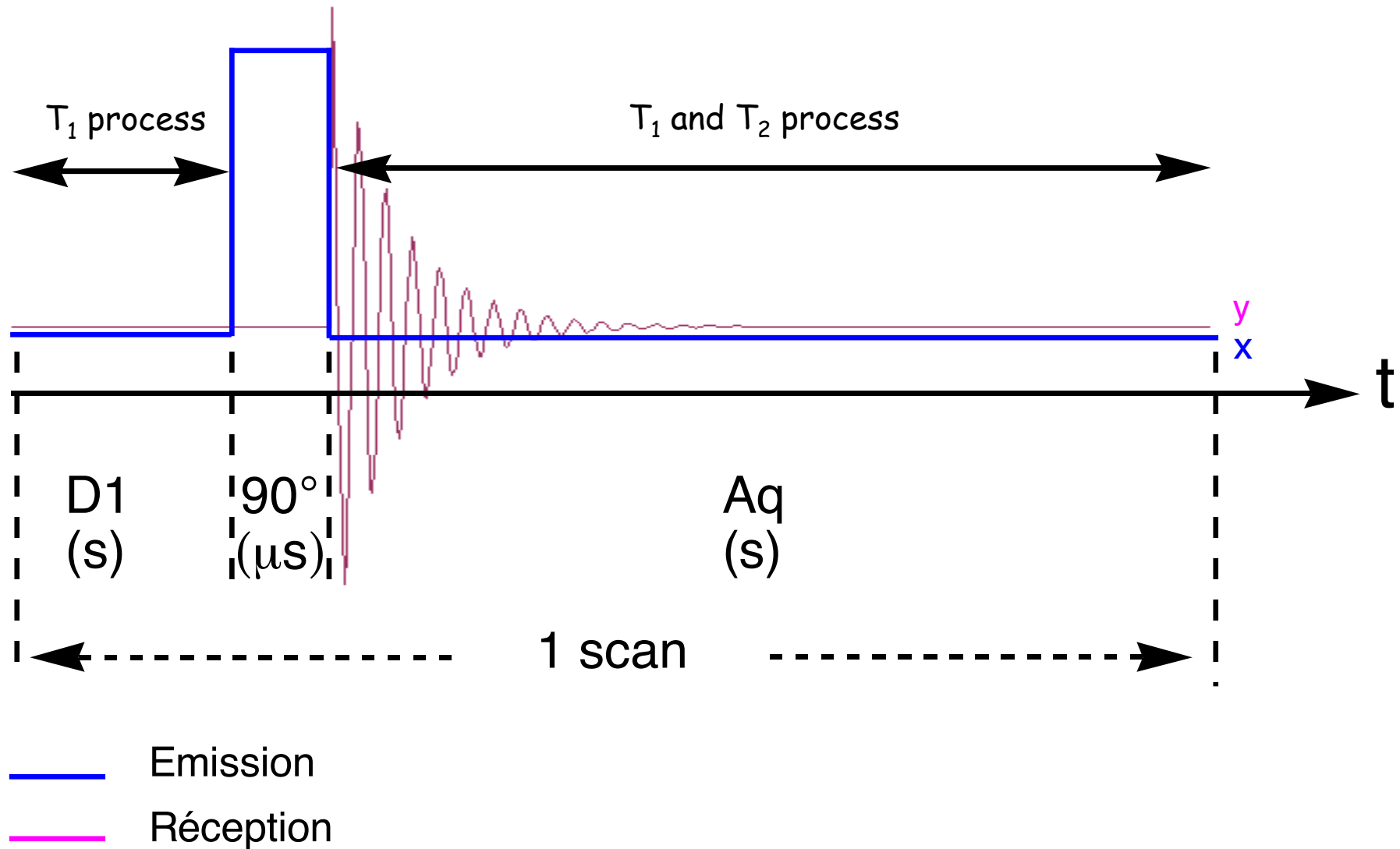


## Signal / Bruit



# Aspects expérimentaux: optimisation

## Séquence 90° FID:





Busy until Waiting for Job!  
 Expt Time 0:00:00 Current User avuser

| Holder | Type | Status    | Disk | Name         | No. | Solvent | Experiment | Par | Orig / Title | Pri | Time    | User     |
|--------|------|-----------|------|--------------|-----|---------|------------|-----|--------------|-----|---------|----------|
| ▼ 13   | 1    | Available |      |              |     |         |            |     |              |     |         |          |
|        | 1    | Available | u    | RMN          | 1   | CDCI3   | N PROTON   |     |              |     |         | avuser   |
| ▼ 14   | 1    | Finished  |      |              |     |         |            |     |              |     |         |          |
|        | 1    | Finished  | u    | 4mecovinsip3 | 1   | CDCI3   | PROTON     |     |              |     | 0:01:08 | doucet   |
| ▼ 15   | 1    | Finished  |      |              |     |         |            |     |              |     |         |          |
|        | 1    | Finished  | u    | YG204        | 1   | CDCI3   | PROTON     |     |              |     |         | gigmes   |
| ▶ 16   |      | Available |      |              |     |         |            |     |              |     |         |          |
| ▶ 17   |      | Available |      |              |     |         |            |     |              |     |         |          |
| ▼ 18   | 1    | Finished  |      |              |     |         |            |     |              |     |         |          |
|        | 1    | Finished  | u    | 4mecovinsip1 | 1   | CDCI3   | PROTON     |     |              |     | 0:01:08 | doucet   |
| ▼ 19   | 1    | Finished  |      |              |     |         |            |     |              |     |         |          |
|        | 1    | Finished  | u    | 4mecovinsip2 | 1   | CDCI3   | PROTON     |     |              |     | 0:01:08 | doucet   |
| ▼ 20   | 1    | Finished  |      |              |     |         |            |     |              |     |         |          |
|        | 1    | Finished  | u    | ASC98BRUT    | 1   | CDCI3   | PROTON     |     |              |     | 0:01:08 | ollivier |

NS = 16  
 D1 = 1  
 SW = 20.618  
 O1P = 6.175  
 AQ = 5.29536

Submit Cancel Edit Delete Add 1 Copy 1 Change User

| Date       | Time     | Holder | Name            | No. | Experiment | ATM | Rotation | Lock | Shim | Acquisitic | Processing | User     | Disk |
|------------|----------|--------|-----------------|-----|------------|-----|----------|------|------|------------|------------|----------|------|
| 2004-11-03 | 13:32:18 | 11     | ff              | 1   | C13CPD64   |     |          |      |      |            |            | coquerel | /u   |
| 2004-11-03 | 13:14:54 | 11     | Yo02009-cr      | 1   | PROTON     |     | ✓        | ✓    | ✓    | ✓          | ✓          | coquerel | /u   |
| 2004-11-03 | 12:59:21 | 11     | Nov03-2004-inas | 1   | PROTON     |     | ✓        | ✓    | ✓    | ✓          | ✓          | lauricel | /u   |
| 2004-11-03 | 12:43:59 | 1      | mepro           | 1   | PROTONnui  |     | ✓        | ✗    | ✓    | ✓          | ✓          | tppca    | /u   |
| 2004-11-03 | 12:36:36 | 27     | HZ169.4         | 1   | PROTON     |     | ✓        | ✓    | ✓    | ✓          | ✓          | rodrigue | /u   |
| 2004-11-03 | 12:30:01 | 26     | ASC96BRUT       | 1   | PROTON     |     | ✓        | ✓    | ✓    | ✓          | ✓          | ollivier | /u   |

# Aspects expérimentaux: optimisation

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|                        |
|------------------------|
| NS = 16 <sup>1</sup> H |
| D1 = 1                 |
| SW = 20.618            |
| O1P = 6.175            |
| AQ = 5.29536           |

† = 6.3s

|                         |
|-------------------------|
| NS = 64 <sup>13</sup> C |
| D1 = 2                  |
| SW = 238.298            |
| O1P = 100.391           |
| AQ = 1.82195            |

† = 3.8s

NS = multiples de 4 (phasage) 8 128

D1 = en secondes 1 0.8

- suffisamment grand pour permettre la relaxation longitudinale si  $NS > 1$  ( $5 \times T1$  pour du quantitatif)

SW = en ppm, largeur de la fenêtre spectrale 14 240

O1P = en ppm, fréq. de la porteuse (milieu du spectre) 6 110

AQ = en secondes 2.5 1.2

- suffisamment grand pour permettre la relaxation transversale
- mais pas trop grand pour ne pas accumuler du bruit